INVESTIGATIVE REPORT

1934-1935

LAKE STATES FOREST EXPERIMENT STATION*

FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

*Maintained in cooperation with the University of Minnesota
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SUMMARY

During the past year the emergency appropriations made for specific studies dictated to a large extent the character of the research activities of the Station. These were: The Shelterbelt Project, The Forest Survey, studies connected with the CCC and the greatly enlarged forestry program of the Lake States region. The regular long-time research projects were not neglected, but no attempt was made to intensify or expand them, since the regular staff gave most of its energies and time to the emergency studies.

The accomplishments of the Station during the last year are grouped largely around these four principal activities.

1. Shelterbelt

Under the Forester's instructions, the technical responsibility for this project was placed upon the Station. Under the direction of the Station, a field study was completed on the possibilities of prairie-plains planting. This included a survey of the soils, natural vegetation, existing windbreaks, and a compilation of weather records. All foreign literature pertaining to the subject was critically reviewed. Since many of the species recommended for planting have been little used heretofore, a laboratory study was undertaken to work out new technique for seed storage and treatment.

A comprehensive report entitled "Possibility of Improving Conditions in the Plains Region by Shelterbelt Planting," now in preparation, will be completed by July 1. This, it is believed, will be the most complete contribution to existing knowledge of the possibilities of tree planting in the prairie-plains region.

2. Forest Surveys and Economic Studies

The Forest Survey received great impetus through the liberal allotment of emergency funds. The field work for the entire forest area of 20 million acres in Minnesota and two units in Michigan, also comprising about 20 million acres, was completed. The final report on Minnesota is now in preparation and should be completed during the spring. Preliminary figures are already available.

3. The CCC Activities

The CCC and the enlarged technical program of the region, particularly the planting program, placed upon the Station the responsibility of supplying the administrative force with information regarding timber stand improvement practices, planting, and advice on forest measurement technique. To provide demonstration areas of the proper cultural operations and also to improve the silvicultural conditions of the experimental forests, the Station increased its own cultural operations, conversion work, and planting on the experimental forests. It also brought together, analyzed, and made available all data accumulated during previous years bearing on these technical activities of the region.

4. Regular Long-Time Projects

The regular projects yielded a number of interesting results bearing upon: soil erosion and the influence of forest cover in preventing run-off; the development of a technique for testing the drought-resistance of planting stock; the effect of climate on survival and development of plantations; forest fire weather; occurrence of fires and the factors controlling them. Further progress was made in developing simplified methods of preparing volume tables, determining the accuracy of forest surveys, and the general improvement of statistical analysis of all forest measurements and computations.

PLANS FOR THE FUTURE

At present, with the regular appropriation for the Department of Agriculture and the Work Relief bill still in the balance, the extent to which funds may be made available for forest research is somewhat uncertain. All plans for the next year must therefore of necessity be tentative in character.

If funds are allotted for the same studies as last year, most of the Station's energies will again have to be devoted to the Shelterbelt Project, the Forest Survey, and activities connected with the CCC, with the possibility that these activities may be on an even larger scale than during the last year. More detailed plans will be discussed later under each project.

The regular long-time projects will be continued, and silvicultural studies particularly those bearing on emergency activities will be intensified.

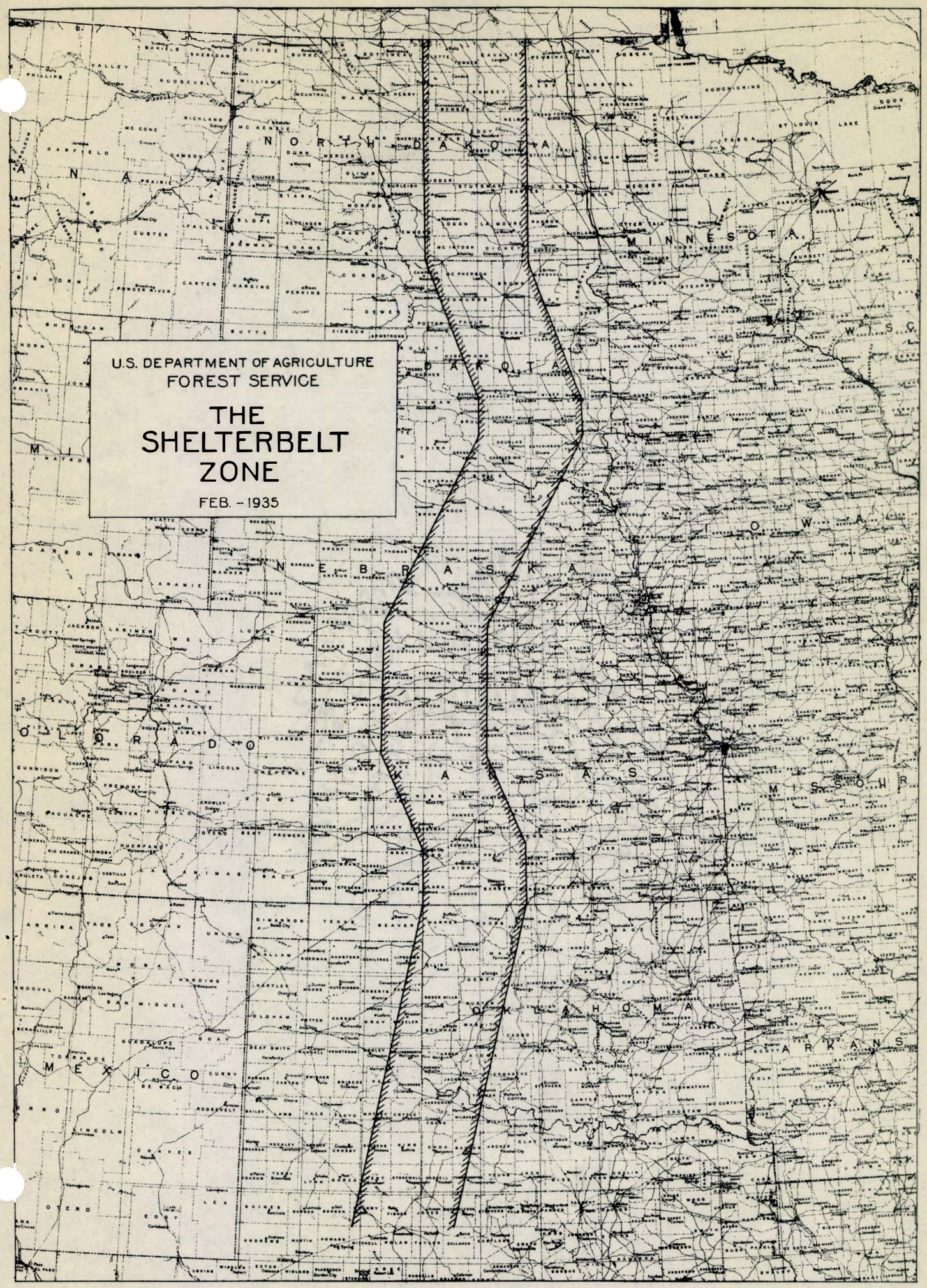
The enlargement of the Upper Peninsula Branch Station from 640 acres to its present size of 4,800 acres, and eventually to 10,000 acres, will involve considerable improvement of the tract, particularly development of logging roads, surveys and preparation of plans for selective logging and sustained-yield management.

In view of the large acquisition program the demand for the establishment of a branch station in Wisconsin has become very urgent. The development of this station may well become one of the major activities during the coming field season.

SHELTERBELT

In June, 1934, the United States Forest Service made public a proposal to plant shelterbelts on about a million acres of farm land within a zone 100 miles wide through the prairie-plains region from North Dakota to Texas. The Station was asked to prepare the technical plans and specifications for this project. After funds had finally been made available and personnel recruited, a comprehensive survey of shelterbelt possibilities was undertaken in the fall of 1934. This included analyses of meteorological data, reconnaissance surveys, compilation of all available information on soils, a study of the natural vegetation, a survey of existing shelterbelts and windbreaks, and an exhaustive review of all the foreign literature in this field. A report embodying the results of this work is now being prepared.

On the basis of precipitation records supplied by the United States Weather Bureau and the survey made by the Station, the shelterbelt zone has


U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
THE
SHELTERBELT
ZONE
FEB. - 1935
NORTH DAKOTA
SOUTH DAKOTA
MINNESOTA
NEBRASKA
IOWA
KANSAS
MISSOURI
COLORADO
OKLAHOMA
ARKANSAS
MEXICO

been located entirely east of the generally accepted "rainfall limit" for tree growth, as shown on the accompanying map. This limit is 15 inches at the Canadian border and 22 inches in Texas. The greater rainfall indicated for the south is to compensate for the higher amount of evaporation in the hotter climate. The shelterbelt zone lies in the transition area between the "short-grass" plains and the "tall-grass" prairies within a fairly good agricultural area.

The occastional occurrence of trees which are found naturally in gulches and valleys throughout the area was given special study. Likewise, a survey of planted groves and windbreaks was made. A strip two miles wide was run from east to west through each state within the shelterbelt zone. Hundreds of groves remain as evidence of the efforts of the early settlers to build up windbreaks. Many of these have survived despite poor location and lack of care, while in other cases there have been decimations of the plantations, both during the current and preceding drought periods. On the basis of the data gathered, it is possible to say with a fair degree of certainty what species should or should not be planted.

Coupled with these appraisals of tree growth and natural vegetation was a survey of the soils. Much of the zone had not been covered by the State Soil Surveys so that it was necessary to do some extensive mapping of the soils. A great deal of additional information was obtained from a recent soil survey made by the Soil Erosion Service. Soils favorable to tree growth (generally the lighter and more sandy ones) were mapped as well as the variable and less desirable ones as a guide to planting.

This phase of the project will be intensified during the coming year in order that localized information on soils may be available as a guide to the administrative force doing the actual planting. Allied with this, a study of sub-soil moisture is planned. This will utilize special technique developed at the University of Nebraska. Further investigations will also be made on selected groves to determine growth and survival of shelterbelts.

An experimental station, where all of the shelterbelt influences can be measured, is badly needed and, if funds are available, an attempt will be made to locate and establish this during the coming year.

FOREST ECONOMICS

FOREST SURVEY

The largest activity of the Station during the past year was the Forest Survey. When emergency funds were made available for this nation-wide project in the fall of 1933, a small crew started field work in northeastern Minnesota. The survey was continued through the winter on snowshoes and was considerably expanded during the summer and fall of 1934. Field work has been completed for Minnesota and half of Michigan. Although office compilations are necessarily somewhat behind field accomplishments, inventory figures are now available for Minnesota, the first state in the country to be so completed in this current Forest Service undertaking.

The method used in the Minnesota survey was the line-plot system, in which sample plots were taken at regular intervals along compass lines spaced 10 miles

apart. The aim was to obtain a representative sample of the present forest conditions in the State as a basis for predicting future growth and yields. Altogether some 5,000 miles of line were run and almost 40,000 sample plots measured. From earlier experience and from a statistical analysis of the present data, it was ascertained that a survey of this kind will determine the extent of forest land in Minnesota with a probable error of less than two per cent.

A survey of the present wood-using industries and their demands upon the forest was coupled with the timber inventory.

The extent of forest land in Minnesota in the various forest types, as shown by the survey just completed, is as follows:

Type	Acres
Aspen	6,875,300
Coniferous Swamp	2,567,300
Non-productive Swamp	763,100
Jack Pine	1,266,000
Spruce-Balsam	1,088,300
Maple-Basswood	954,100
Bottomland Hardwoods	616,100
Oak	573,500
Scrub Oak	542,400
White Pine	233,700
Norway Pine	170,500
Miscellaneous	494,100
Deforested	3,557,300
	19,701,700

These figures are notably different from earlier estimates in the following respects:

1. The total area of forest land is two million acres less than has been commonly supposed.

2. The aspen type falls four million acres short of some of the earlier figures. The previous figures undoubtedly included some areas now classified as deforested brush.

3. Earlier figures for the pine type were a third greater than that found in the present survey.

4. Although the area of northern hardwoods (maple and basswood) turned out to be somewhat as expected, there is a greater area of bottomland hardwoods and a correspondingly smaller acreage of oak than was indicated in previous estimates.

Aside from their value in showing the general forest situation in the State, the Forest Survey statistics will be put to increasing use in connection with plans for sustaining existing wood-using industries, and other local problems. The tendency in the next stage of lumber development should be to bring the sawmill production

more into line with the sustained-yield capacity of the forests. In order to do this, accurate figures on the remaining stands and their rate of growth are essential. Survey figures are consequently being assembled by economic units or territories surrounding certain groups of mills and industries, in order that self-sustaining units may be built up.

If sufficient funds become available, a special drive will be made to complete the balance of field work remaining to be done in Michigan and all of Wisconsin during the coming year. Whether the present forest survey organization of the Station, after it completes the Lake States, should be extended to the Central States is a matter which may come up for decision during the year.

OTHER ECONOMIC STUDIES

Closely allied with the Forest Survey in purpose and method, the New Public Domain project has absorbed the time of one regular Station man, one Junior Forester technician, and a small group of computers. This project grew out of the fact that there are upwards of 20 millions of acres of forest land in the Lake States which is in process of abandonment by the owners and which seem destined sooner or later to revert to public ownership.

State legislatures have been in the habit of temporizing with the problems presented by this abandonment of land and by various moratoriums and bargain tax laws have put off the final settlement. Important social and economic consequences are associated with the disposal of these lands, and it is not surprising that the responsible state agencies want to have a very realistic and detailed picture of the situation before making final moves. If all of the long-term delinquent land is confiscated by the State, how many bona fide farmers will be dispossessed? How much real farm land will be taken over, what kind of timberland will the State acquire, what will be the effect on the local communities? These are some of the questions which must be answered.

The Station made some contribution toward resolving the general picture in regard to these forest lands when it participated in the preparation of Land Use Reports in Wisconsin and Minnesota. At the present time it is appraising the use and quality of the land which has been on the delinquent tax lists for long periods of time.

It is quite obvious that if taking over the delinquent property means acquiring large acreages of cut-over and low-grade forest land long ago abandoned, it is one thing. If it means taking over farm land now occupied and dispossessing poor settlers, it is quite another. Preliminary figures for Minnesota indicate that only about 2.3 per cent of the long-term delinquent land in the northern counties is improved farm land. Even this small acreage may possibly justify some special kind of treatment.

To determine the relationship between ownership, character of delinquent land, and present use, the procedure at the Station has been to determine the economic status of each plot covered in the Forest Survey and to subject the data to special analysis. In the three largest units of northern Minnesota, the long term delinquent land breaks up into the following classes of land cover:

	Per Cent
Aspen-Birch	41.5
Deforested	27.1
Coniferous Swamps	8.1
Balsam	6.6
Jack Pine	4.5
Northern Hardwoods	3.5
Bottomland Hardwoods	2.9
Crop and Pasture	2.3
Non-productive Swamp	1.6
White and Norway Pine	1.2
Scrub Oak	.7

It is significant that over two thirds of the delinquent land consists of aspen or completely deforested land. In contrast to this is the very small proportion of crop and pasture land, of which a part is also abandoned.

It is planned to make similar economic studies in Michigan during the coming year.

FOREST MANAGEMENT

CCC WORK IN THE IMPROVEMENT OF YOUNG STANDS

With the advent of the CCC, forest culture has become something more than mere theory. Timber stand improvement work, such as thinning, pruning, weeding, cleaning, and release cutting together with the establishment of forest plantations and their subsequent care have been activities of high priority and many thousands of acres have been treated. Results of experiments in care of second-growth forests are thus especially valuable at this time to guide the practice of intensive forestry that is now going on in the Lake States. It is expected that this work will be continued in a greatly expanded form. The Station has been under pressure to answer the many difficult technical questions involved in this work. For this reason a special effort was made during the year to assemble and bring to a head all work underway at the Station which might throw light on the silviculture of second-growth forests.

Comparative Girdling Tests

Since girdling offers a cheap way of eliminating undesirable trees, a comparative test of several methods of girdling was made on a typical stand of young hardwoods as found on the Hiawatha National Forest. The marking was designed to release the smaller and somewhat younger sugar maple and other desirable species from the overtopping pin cherry, which ranged from one to seven inches in diameter. A summary of the results are shown in the following table.

Cost of Different Types of Treatment

Method	CCC Man Hrs. to Treat 1/2 Acre	No. Trees Per Acre Treated	Basal Area Treated per CCC Man Hr.	Cost Per Acre Treated 1/
Trees cut with axe	13.40	15	0.390	$ 4.20
Girdled Marking Tool	4.20	36	1.134	1.33
Girdled Axe	5.35	47	1.680	1.72
Girdled Chain Saw	4.25	53	2.188	1.36
Girdled Draw Knife	3.45	56	3.198	1.15

1/ Based on a 6-1/2 hour day at $1.00

Girdling with some of the tools used was found to be from five to eight times faster than cutting with the axe and lopping the slash.

Supplemental Planting of Hardwood Land

It is a well-known fact that in the original forests white pine reached its best individual development in mixture with hardwoods. This species, however, is entirely lacking in the second growth which follows logging. In the spring of 1929, about two acres of a tract which was clear-cut the preceding winter on the Upper Peninsula Experimental Forest was planted to white pine. About 200 trees per acre were set out in skid trails and openings. Beginning with the second year, annual liberation cuttings were made for three years and then discontinued.

When the trees were remeasured in 1934, 70 per cent had survived. They averaged 5.9 feet tall and some trees were 11.5 feet in height. Besides being thrifty, the planted trees show no sign of weevil damage.

Release of Norway Pine from Overtopping Aspen

Release cutting experiments established three years ago in a plantation of Norway pine on the Superior National Forest were re-examined in 1934. In 1931, there were 375 Norway pine per acre and about 1,200 aspen and other broad-leaved trees. The pine ranged from 9 to 28 feet in height, and the aspen from 15 to 45 feet. As a result of a light release cutting, the pine increased its rate of diameter growth one and one-half times over that of the untreated area; a heavy release cutting produced a growth two and one half times larger than the check plot. No cases of injury to the pines as a result of sudden exposure were noted. Aspen suckers came up prolifically the year following cutting, but at the end of three years none seemed sufficiently tall or vigorous to overtake the smaller pines, none of which were less than five feet tall when the experiment was started.

Release of Underplanted White Pine

An analysis was made of the five-year records of release cutting experiments made on the Higgins Lake State Forest in cooperation with the

University of Michigan. In 1929, white pine, which had been planted beneath a stand of oak 16 years previously, was only from two to three feet in height, with only an occasional tree of greater size.

Several degrees of release cutting were tried, from almost complete removal of the overhead canopy to a very light cut which removed only the suppressed oak and in which the limbs and brush over-hanging the pines were pruned. The under-planted pine showed the most striking response on the clear-cut plot. A great increase in general vigor and density of foliage was plainly evident by the end of the second year. The height growth for this plot averaged 4.3 feet for the five-year period following release, whereas for the check plot growth was only 1.6 feet, and on the lightly treated plot even less. The response in height growth was thus almost directly proportional to the degree of cutting.

Although complete removal of the overstory resulted in the best height growth, it was not without deleterious effects. Damage by the white pine weevil, while insignificant on all plots where any overhead shade was left, was heavy on the clear-cut plot. Sudden exposure by the removal of the cover also took its toll on the clear-cut plot, but this loss was confined chiefly to badly suppressed pines.

In parts of the stand where aspen was in mixture with the oak, a mass of suckers immediately appeared, constituting greater competitors of the smaller pines than the original trees. The larger pines were better able to keep ahead of the suckers than the smaller ones, but in such stands a second release cutting was needed at the end of the third year. It is apparent from these studies that some degree of cover must be left to reduce suckering, sprouting, and weevil damage, even though some growth of the pine must be sacrificed.

Thinning in Aspen

What to do with the vast acreage of young aspen in the Lake States is still largely an unanswered question. Six thinning plots in 20-year old aspen established in 1929, remeasured in 1934, throw some light on the question. The possibility of growing aspen itself on good sites has received some thought, and it was with this idea in mind that these experiments were established.

Certain selected "head trees" were chosen for release with spacings of 10-1/2, 15 and 20 feet. No attempt was made to release the remaining stand. The trees cut were mostly in the dominant and co-dominant classes. The purpose was to devise a cutting which would produce large-sized, high-quality aspen at an early age.

The increment in diameter was in direct proportion to the severity of thinning. Height growth, however, did not appear to be affected in any regular manner. The basal area increment of the "head trees" on most of the thinned plots was greater than on similar trees on the unthinned plot, as shown in the following table.

Spacing (Feet)	Site Index (50 years)	Basal Area per Acre* in Square Feet		
		1929	1934	Increment
Check	69	36.1	48.8	12.7
10-1/2	75	30.2	48.0	17.8
10-1/2	67	25.3	42.3	17.0
15	73	19.1	31.6	12.5
15	80	28.4	45.0	16.6
20	71	12.4	22.6	10.2

* Head trees only.

So far the thinning does not appear to have caused any stimulation in the growth of large limbs which would tend to reduce quality.

Jack Pine Thinning

Remeasurement of five jack pine thinning plots established in 1929 on the Chippewa National Forest showed that, while heavier thinning resulted in the best diameter growth of individual trees, thinning to about 60 per cent of the normal basal area is best if a pulpwood crop is to be expected within 15 years after thinning. The plot thinned to 60 per cent of the normal value as given by yield tables put on the largest basal area increment of any of the plots (32.7 square feet in five years) and is now up to 81 per cent of normal. On the other hand, there is some evidence to show that the heavier thinnings retarded the rate of height growth.

CUTTING EXPERIMENTS IN MERCHANTABLE STANDS

Hardwood-Conifer Type

At the Upper Peninsula Branch, no cutting had been done in the hardwood-conifer type before last year. The timber was inferior to that previously cut and there was also a considerable volume of defective and dead cedar. About 50 acres of this type are being logged this year with an attempt made to salvage as much of the inferior material as possible. The better trees are left uncut. A similar cutting last year yielded a return of around $8.00 per acre.

Pines

Four methods of cutting were tried out in a Norway pine-jack pine stand on the Cutfoot Experimental Forest. The material removed was used by the administrative organization for the construction of ranger and guard station buildings.

Black Spruce Type

A cutting experiment in a merchantable stand of upland black spruce was established on the Superior National Forest. Three methods of cutting were used. First, all trees were cut, even those below merchantable size. Second, a strip cutting was used in which only trees containing at least two pulp sticks were cut. This left a stand of about 300 trees per acre below merchantable size. Third, a light selection cutting was made which removed only 25 per cent of the merchantable volume. The intention here was to use a method sufficiently light to prevent windfall. On certain parts of the plots the soil was scarified to determine the effect on reproduction. There was a good seed crop in the fall and the plots should soon show some results.

Cutting in swamp black spruce will be undertaken during the coming year.

EXPERIMENTAL FORESTS

Cultural Work on Experimental Forests

Through the aid of CCC and other emergency workers, release cuttings and other stand improvement measures were put into effect on five of the experimental forests. On the Pike Bay Unit (Chippewa National Forest), defective aspen was removed on 70 acres. At the Superior Branch, 65 acres of balsam and spruce were released from an overhead canopy of aspen and paper birch. One hundred acres of second-growth northern hardwoods were given treatment at the Upper Peninsula Branch. A 40-acre stand-improvement plot, which included improvement cutting, pruning, and planting, was established at the Michigan Forest Fire Experiment Station. At all locations, variation in treatment and methods were tried with the establishment of sample plots for future use in evaluating results.

Expansion of Upper Peninsula Branch

The National Forest Reservation Commission has approved for purchase some 4,100 acres of forest land adjacent to the present Upper Peninsula sub-station at Dukes, Michigan. This unit is to be the center of a 10,000-acre experimental forest. This is the first experimental forest purchase unit of this size to be selected in accordance with the new policy of the Commission.

The 4,800 acres which have been optioned or are already owned are four fifths virgin hardwood or hardwood-conifer timber and the balance restocking cut-over land. At present, the balance of the 10,000 acres is approximately two thirds virgin hardwood and swamp timber. If this whole area could be acquired in its present condition, probably 7,500 acres of land would be in suitable shape to put under immediate management on a sustained-yield basis. Considering the net annual growth to be about 150 board feet per acre per year, a very conservative figure, it should be possible to cut well over a million feet of timber annually for an indefinite period. When the cut-over land comes into productivity later on, it should be possible to raise this figure considerably.

If these plans materialize, part-time work will be provided for 75 or 100 men with an annual income of perhaps two or three hundred dollars each. Practically all of these people are local settlers living on small adjacent farms so that this added income, together with what they can raise on their farms, should increase the general standard of living and place the whole community on a permanent basis.

During the present year, emphasis will be placed on construction of roads, firebreaks and other improvements necessary to place the area on a sustained management basis. It is expected that this work will be done with emergency funds (CCC and Work Relief) and will provide a great deal of additional employment to local people.

Besides the construction work, it will be necessary also to obtain technical information on volume of timber, age classes, rate of growth, type distribution, etc., in order that a proper basis may be had for scientific forest management of the tract.

Proposed Wisconsin Sub-Station

For some time the Station has contemplated establishing a branch station to serve the needs of State and Federal Forestry Work in Wisconsin. This has

been postponed several times, however, because of lack of funds. With the advent of the CCC and other emergency activities, the need for this Station has become urgent. With the possibility that emergency funds will become available to construct buildings, roads and the other necessary improvements, it is planned to go ahead with the location of a branch station and experimental forest in Wisconsin if a suitable location can be found and agreed upon.

FIRE STUDIES

In order to use the emergency funds to advantage and to handle the increased volume of work involved with the overhead available, precedence was given during the past year to projects on which emergency workers could be used, and others which would normally have been completed were held in abeyance.

The major projects handled have been: The compilation of available precipitation data for the three Lake States as a basis for a study of rainfall probability and distribution; a field study of fire damage on typical hardwood areas in Michigan and Wisconsin; and the transcribing and coding of data from the Michigan Forest Fire Reports for tabulation and analysis.

In addition, the detailed study of fire weather conditions started at Roscommon in 1930 was continued; additional experimental burning plots were established in second-growth hardwoods and jack pine in connection with the study of fire behavior and damage; the plot established in 1932 to determine the effect of periodic fires was reburned; an intensive study of inflammability and litter moisture was carried on in connection with the fire weather study; and the periodic examinations, tallies and measurements were made in connection with the season of burning, slash disposal and fire damage studies.

Most of the data obtained, however, has yet to be worked up. It was also necessary to postpone further work with chemical fire extinguishers.

FORESTATION

HURON PLANTING EXPERIMENT

Planting experiments were continued on the Huron National Forest in accordance with the 10-year program embarked upon in 1931. There was rather a striking contrast between the results in 1933 and those during the past year, due to different distribution of rainfall during these two growing seasons.

The year 1933 was considered as probably the worst drought year on record on the Huron National Forest. Yet, as may be seen in the table below, the rainfall on the various experimental blocks during the growing season averaged from 1.83 to 3.23 inches greater than in 1934. The data in the accompanying table shows, however, that first-year survivals were uniformly better in 1934 than in 1933. These results are a reflection, not of the amount of rainfall but of its distribution.

In 1933, there was an unusually wet spring followed by a warm early-summer. As a result, the trees produced long succulent shoots and had no chance to develop resistance for the coming Saharan conditions. Then the rain abruptly ceased and on the Tawas District (including the Gordon Creek and Sand Lake Blocks) the lowest combined July-August precipitation on record resulted. On the White Pine Block a good shower broke the July drought and on the Mack Lake Block occasional showers diminished the deleterious effects of both July and August conditions. Accompanying this diminution of precipitation were abnormally high temperatures. The survivals reflect these conditions quite accurately: Losses were enormous on the Gordon Creek and Sand Lake Blocks, less on the White Pine Block, and least on the Mack Lake Block.

The spring of 1934 was drier than normal; consequently the trees produced short shoots only. Although maximum temperatures even higher than those of 1933 were recorded and the rainfall was less, first year survivals were uniformly fair to excellent in 1934. The answer evidently is rainfall distribution. No monthly totals were as low in 1934 as in 1933, and rainfall was sufficient for a majority of the trees to make slight growth without exhausting the reserves of moisture in the upper soil layers.

Survival Percentage - End of First Year
Huron Planting Experiment

Block and Plot	Norway Pine				White Pine			J.P.*	S.P.**		Rainfall May thru Mid-Nov. Inches.
	1-0	2-0	1-1	2-1	2-0	1-1	2-1	2-0	2-0	2-1	
1933											
Gordon Creek (8)	3	3	6	15	5	0	9	14	13	36	13.47
Sand Lake (19)	4	9	10	28	6	11	17	23	22	49	13.92
White Pine (22)	18	38	48	59	46	55	54	21	31	76	15.06
Mack Lake (32)	53	70	83	93	54	71	77	50	72	97	15.79
1934											
Gordon Creek (9)	71	84	86	91	75	80	89	61	84	98	11.64
Sand Lake (18)	47	75	76	92	73	66	86	36	64	91	11.87
White Pine (23)	47	58	48	83	48	59	67	34	66	86	11.83
Mack Lake (33)	74	98	86	96	74	89	90	51	70	98	13.08

* Jack Pine
** Scotch Pine

The table also indicates the rather general superiority of transplant over seedling stock and the comparatively good resistance of 2-1 Scotch pine to 1933 conditions. In addition, it might be pointed out that the results with jack pine and, to a lesser extent, 2-0 Scotch pine, are not considered representative of the species since the stock employed was not as well hardened-off as it should have been and suffered abnormally high winter injury.

RESURVEY OF OLDER PLANTATIONS

The Station made a complete survey of plantations in 1924 and, on the basis of the data collected, prepared recommendations for planting. Over 10 years have elapsed and many changes have undoubtedly occurred. Plantations have been subjected to severe drought and intense competition. A resurvey of the same plantations should throw valuable light on the planting problem, and one will be undertaken as soon as additional emergency funds are made available.

SAND-HILL PLANTING IN THE DAKOTAS

The Northern Plains Branch Station was established in 1931 in McHenry County, North Dakota to test the feasibility of forest planting on poor, sandy, non-agricultural land. There are at least 300,000 acres of such land in this state. On the basis of the work done by the Station, National Forest Purchase Units aggregating 260,000 acres have been approved in North Dakota by the National Forest Reservation Commission.

The results of four seasons planting work were recently summarized. Some species have demonstrated their unfitness for planting in this area, but others

have shown a surprising ability to survive and make growth in the heart of the northwest drought area.

Eastern and Rocky Mountain red cedar, ponderosa pine, Scotch pine, and jack pine are the conifers which appear to be best adapted to the conditions of this region. The best hardwoods are green ash, bur oak, hackberry, white elm, and cottonwood. Of all species, red cedar and green ash seem to be definitely suited for large-scale planting work, plantations of these two species having shown a survival of 40 to 65 per cent at the end of the third growing season. This is a very good showing indeed.

Furrow planting has been tried and is satisfactory for some species but definitely not suited to others. Cultivation of the planted trees for a period of two to five years will probably be a necessity.

Planting tests will be continued and an especial effort made to determine the feasibility of cultivation.

LARGE-SCALE CONVERSION TESTS

Attempts at converting the aspen type to conifers were carried out on an expanded scale on the experimental forests on the Chippewa and Superior National Forests through the help of the CCC. Altogether, there are now some 87 acres that have been so treated on these units. In cooperation with the Nicolet National Forest in Wisconsin, a 40-acre conversion experiment was established on burned-over hardwood land now occupied by inferior species and brush.

DROUGHT RESISTANCE OF PLANTING STOCK

The technique for testing the drought and heat resistance of seedlings in the "drought machine" developed last year was further improved and 20 test runs made, involving the use of over 600 trees.

In addition to tests of drought resistance, a series of tests were run to determine comparative resistance to high temperatures. One important finding resulting from this study was that, under conditions of high humidity, seedlings were less resistant to the effects of high temperatures than at low humidities. This observation indicates that transpiration has a cooling effect and thus tends to protect the plant from high temperatures. This result is a decided contribution to the solution of a problem which is under much discussion among plant physiologists at present. Continuation of this work is contemplated.

FOREST MEASUREMENTS

Much of the mensuration work during the past year was done in connection with the Forest Survey. The work connected with the estimates of the several forest types presents certain features which have been overlooked in previous work on this subject. A correct method of determining errors of area and volume estimates was developed by the Station in cooperation with the School of Business Administration of the University of Minnesota. This method was applied to the data obtained in the survey of four units in Minnesota.

A method of predicting growth, based on the data obtained by the survey, was worked out. Although the problem of mortality presented several difficulties, these were overcome and an estimate of the growth for the entire region is now being made.

A simplified technique for the construction of board foot volume tables was developed. This method requires a very small number of field measurements and a minimum amount of office computation. In addition to these advantages, it also gives more accurate estimates of the truly merchantable contents of trees than former tables.

In addition to the regular mensuration studies, a large amount of data from numerous experiments was analyzed by statistical methods. Outstanding among these was the analysis of a large volume of National Forest plantation survival counts for the purpose of determining their accuracy. As a result of this, a guide was prepared which shows the number of trees to be counted in order that any chosen degree of accuracy may be attained on areas ranging from 40 to 640 acres.

EROSION-STREAMFLOW

STUDY OF THE WATER CYCLE

Tanks and instruments were installed for measuring runoff and percolation from the 10 concrete lysimeters built at the Upper Mississippi Valley Erosion Station at LaCrosse, Wisconsin, a year previously with Public Works funds. Preliminary measurements of percolation indicates a fairly close similarity in the behavior between lysimeters. Oak seedlings were planted in some of the lysimeters and others will be sown to grass and different crops in 1935. In years to come, it is hoped that clear-cut differences with respect to what happens to the water that falls on the surface can be found between those lysimeters supporting tree growth and those in which herbaceous plants are growing, so that the value of the forest from the standpoint of moisture conservation can be better evaluated.

RUN-OFF FROM FORESTED AND PASTURED WATERSHEDS

Additional observations were made on the capacity of the timbered watershed at the LaCrosse Erosion Station to absorb exceptionally heavy rainfall. In the storm of July 5, 1934, in which 3.1 inches of rain fell, the highest intensities ever recorded by the United States Weather Bureau at LaCrosse, Wisconsin were reached. Rain actually came down at the rate of 7.68 inches per hour for five minutes compared with a theoretical maximum of 10 inches. In spite of the breakage of the diversion ditch, which cuts off the water from the field above, almost no damage was done to the forested watershed. The run-off from the cleared and grazed watershed was exceptionally heavy.

PUBLICATIONS DURING THE PAST YEAR

Review of Norwegian Article: Experiments with Western North American Trees
By J. H. Stoeckeler
Journal of Forestry, Vol. 32, No. 1, January 1934.

Forestry Throws a Life Line to Stranded Communities
By Raphael Zon
Minnesota Conservationist, April 1934.

Periodic Land Use Studies for More Effective Planning
By Bernard Frank
Journal of Forestry, Volume 32, No. 4, April 1934.

Approach of Understocked Stands to Normality
By S. R. Gevorkiantz
Journal of Forestry, Vol. 32, No. 4, April 1934.

A Hypsometer for Woodsmen
By S. R. Gevorkiantz
Journal of Forestry, Vol. 32, No. 5, May 1934.

Volume, Yield and Stand Tables for Tree Species in the Lake States
By R. M. Brown and S. R. Gevorkiantz
Technical Bulletin 39 Revised, Minnesota Agricultural Experiment Station, June 1934.

Back of It All - Forest Research
By Raphael Zon
The Forestry News Digest, June 1934.

Conservation and the Farmer
By Raphael Zon
Minnesota Conservationist, July 1934.

Land Utilization in Minnesota - A State Program for the Cut-Over Lands
By Raphael Zon, et al., Members of Committee on Land Utilization appointed by Governor Floyd B. Olson
University of Minnesota Press, September 1934.

Reliability of Forest Surveys
By B. D. Mudgett and S. R. Gevorkiantz
Journal of American Statistical Association, Vol. 29, No. 187, September 1934.

Subdivision of the Upper Peninsula Experimental Forest on the Basis of Soils and Vegetation
By S. A. Wilde and H. F. Scholz
Soil Science, Vol. 38, No. 5, November 1934.

The Plains Shelterbelt Project
By C. G. Bates
Journal of Forestry, Vol. 32, No. 9, December 1934.

The Plains Shelterbelt Project
Minnesota Conservationist, November 1934.

More About Calcium Chloride as a Fire Retardant
By J. A. Mitchell
Journal of Forestry, Vol. 33, No. 1, January 1935

Surplus Land - A Conservation Problem
By R. N. Cunningham
Agricultural Yearbook, 1935

Release of Young Norway Pine from Aspen Competition
Journal of Forestry, Vol. 33, No. 2, February 1935.

TECHNICAL NOTES

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73	Stand and Yield Table for Jack Pine
74	How Much Solid Wood in a Cord?
75	Estimating Fire Damage in the Lake States
76	Damage to Young Growth by Logging
77	Damage to Advance Growth by Slash Disposal
78	Relative Hazard and Estimated Cost of Protection by Forest Types - Lake States
79	Mortality in Selectively-Cut Northern Hardwoods
80	Planting Under Aspen Can Be Made Successful
81	Is Prairie Forest Planting Practical?
82	Control of Rabbit Injury
83	Use of Calcium Chloride in Forest Fire Control
84	Is Jack Pine a Prolific Seeder?
85	Forest Surveys an Aid to Sustained Yield Production
86	Ownership and Use of Land Determine Tax Delinquency

MONTHLY PUBLICATIONS

The Forest Research Digest
Begun in January 1935 (Mimeographed)
Distributed to United States Forest Service Personnel in Region 9

MIMEOGRAPHED MANUSCRIPTS

Translation of Junack's "Thinning Pine Forests"
By S. R. Gevorkiantz

The Soil as a Guide to Stand Treatment
By E. I. Roe

MANUSCRIPTS IN PROCESS OF PUBLICATION

The Statistical Method in Forest Research
By S. R. Gevorkiantz
Submitted for publication in the Proceedings of the Michigan Academy of Science, Arts and Letters

Dissemination of Jack Pine Seed from Seed Trees and Slash
By F. H. Eyre
Submitted for publication in the Proceedings of the Michigan Academy of Science, Arts and Letters

Possibilities of Shelterbelt Planting
By C. G. Bates
Submitted for publication in the Proceedings of the Michigan Academy of Science, Arts and Letters

Shelterbelts - Futile Dream or Workable Plan
By Raphael Zon
Science, Vol. 81, No. 2104, pp. 391-4, April 1935.

Photoperiodism in Forestry
By E. I. Roe and S. R. Gevorkiantz
Submitted to the Journal of Forestry

Review of "Diameter Distribution Series in Even-Aged Loblolly Pine Stands in Maryland."
By R. H. Blythe, Jr.
Submitted to the Journal of Forestry.

The Protectors of our Game and Fish Resources
By C. M. Aldous
Submitted to the Minnesota Conservationist

The Minnesota Caribou
By C. M. Aldous
Submitted to the Minnesota Conservationist

Lethal Temperatures for Conifers and the Cooling Effect of Transpiration
By H. L. Shirley
Submitted to the Journal of Agricultural Research

Causes of Decadence in the Old Groves of North Dakota
By H. F. Scholz
U. S. D. A. Circular No. 344, March 1935.

The New Public Domain - What Is It?
By H. C. Moser
To be published in the Minnesota Conservationist

Possibility of Improving Conditions in the Plains Region by Shelterbelt Planting
By Raphael Zon, C. G. Bates, et al.
To be completed by June 1.

Silvicultural Effects of Release Cuttings in Plantations of White and Norway Pine.
By L. J. Young and F. H. Eyre
Submitted to the Journal of Forestry.